

Antibiotic Properties of Honey Produced by the Domestic Honey Bee *Apis mellifera* (Hymenoptera: Apidae)

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Although medicinal qualities have been claimed for honey since ancient times (Crane, 1980), its curative effect has been attributed variously to the hyperosmotic sugar content, and to unique, undefined components. Our studies suggest that honey from different sources differs in its antibiotic qualities, and that their antibiotic qualities may, at least in part, be derived from fungal foraging by bees.

In order to test the bacteriocidal properties of honey, pure cultures of the bacteria *Staphylococcus aureus* and *Escherichia coli* were used as bioassay organisms. Two nutrient agar plates (peptone/beef extract) were individually smeared with these two species. Three samples of honey were selected for testing as follows: Sample number 1, Glen Park region of San Francisco, California, extracted in October 1984; sample number 2, West Point, Calaveras Co., CA, extracted in September 1984; and sample number 3, West Point, Calaveras Co., CA, extracted in October 1984. The cultures of both bioassay species were treated with one drop from each of the three sources of honey, spaced at equal distances on each plate. After 48 hours of incubation the plates were examined for inhibition of the bioassay bacterial cultures.

Inspection of the bioassay cultures clearly indicated no inhibition of either bacterium by honey sample number 1, from San Francisco, while there was complete inhibition of both bacterial species by the honey from the West Point sources. Examination of the plate containing the *S. aureus* culture revealed a circular area of complete absence of bacterial growth measuring 25 millimeters in diameter through the point of honey administration on the plate surrounding honey sample #3, and a 26 × 35 millimeter tear-drop shaped area on the plate surrounding sample #2. Similar measurements taken through the center of the honey administration on the *E. coli* plate revealed a circular area of no bacterial growth of 9 millimeters in diameter for sample #2, and a clear area 9 × 14 mm for sample #3. It was striking that the *S. aureus* culture was clearly more sensitive to the honey application than was *E. coli*. The clear areas of apparent antibiosis around the West Point honey applications were evaluated to determine if the bacteria were killed, or only inhibited, by inoculation of standard nutrient broth media with specimens taken from the inhibition areas of each test plate. Examination of these broth cultures indicated absence of viable *S. aureus* bacteria, but inhibition without complete death in *E. coli*. This conclusion was supported by examination of inhibition areas over a period of one week. There were very small resistant colonies in the *E. coli* inhibition areas.

It should be noted that the bees from the West Point apiary were observed aggressively collecting spores from the willow rust (tentatively identified as *Me-*

lampsora bigelowii) in October 1984 (Williams and Tomlinson, 1985). It was apparent in October that the rusts were the primary foraging objective of the bees in this region.

These observations suggest several important points. First, some honeys definitely have antibiotic properties. It was of interest, however, that some honeys definitely did not have antibiotic properties, at least in reference to the two species of bacteria observed. Second, the antibiosis was more effective on some species of bacteria than on others. Third, there was a positive correlation between antibiosis of honey and fungal foraging by these bees. The San Francisco bees showed no sign of foraging on fungi at the time of these observations. In San Francisco, due to the mild climate, the preferred pollen and nectar sources seemed adequate to fully attract and occupy the bees at this time. These San Francisco bees were also offered mixed cultures of molds, and there was no evidence of foraging on these by the bees. Fourth, the fact that no antibiosis on these two species of bacteria occurred from the administration of the San Francisco honey suggests that the hyperosmotic properties of honey did not in itself impart bacteriostatic or bacteriocidal qualities to the honey.

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